MICROSTRIP FRACTAL PATCH ANTENNA FOR S-BAND APPLICATIONS

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Abstract: In this paper, the design and simulation of a Microstrip Fractal patch antenna for different dielectric constant substrate with frequency band of 2-5 GHz (S- band) is proposed. Here we propose a technique to overcome these drawbacks, mainly to improve bandwidth and to reduce isolation loss by making use of the fractal geometry. The fractal geometries can improve impedance matching. The proposed fractal antenna shows multiband characteristics with improved bandwidth. The proposed antenna finds its application in weather radars, communication satellites and wireless communications. If the material's of dielectric substrate is resulting, escalated, and depression of microstrip patch antenna. The coordinate geometry is result of back-and-forth in bandwidth, impedance and efficiency. FR4 is used for determine the performances. Feeding technique is used to coaxial probe-feed. The Measurement likes width, feed-point coordinates, length, and ground measurement for substrate is determined. The process of antenna is performed using the Method of Moments (MOM) based on IE3D from Zeland Software Inc, USA.

Keywords: Microstrip patch antenna, MOM, feed-point coordinates, fractal antennas, dielectric substrate,

1. **Introduction:** During the past ten years, the mobile radio communications industry has grown by orders of magnitude, fuelled by digital and RF circuit fabrication improvements, new large-scale circuit integration, and there miniaturization technologies which make portable radio equipment smaller, cheaper, and more reliable. These trends will continue at an even greater pace during the next decade. Wireless operations, such as long range communications, are impossible or impractical to implement with the use of wires. The term is commonly used in the telecommunications industry to refer to telecommunications systems (e.g., radio transmitters and receivers, remote controls, computer networks, network terminals, etc.) which use some form of energy (e.g. radio frequency (RF), infrared light, laser light, visible light, acoustic energy, etc.)

Microstrip patch antennas are attractive due to their light weight, conformability and low cost. These antennas can be integrated with printed strip-line feed networks and active devices. The resonant length of the antenna is slightly shorter because of the extended electric "fringing fields" which increase the electrical length of the antenna slightly. In order to design a compact Microstrip patch antenna, substrates with higher Dielectric constants must be used which are less efficient and result in narrower bandwidth. Hence a trade-off must be realized

between the antenna dimensions and antenna performance. Microstrip patch antennas are increasing in popularity for use in wireless applications due to their low-profile structure Therefore they are extremely compatible for embedded antennas in handheld wireless devices such as cellular phones, pagers aerospace, radar, satellite communication, defense, missiles and many more etc. The telemetry and communication antennas on missiles need to be thin and conformal and are often Microstrip patch antennas. Microstrip antenna consists of conducting patch of any planar/geometry or non-planar geometry on one side of dielectric substrate with ground plane on other. Extended of substrate which in reducing bandwidth, radiation efficiency and. Thus selection of dielectric substrate plays an almost important role in designing method of antenna.

2. ANTENNA DESIGNING - The radiations pattern can be circular, triangular, hexagonal, dipole sector etc. Here Triangular is used other due to some reasons-

- Due to greater bandwidth, more area

- Low time required

- Slot process easier

- Easy to design

The triangular microstrip patch antenna dimensions on ground surface as length L, width W and measure the dielectric materials constant as width w, permittivity ϵ, length l, and height h. the impedance change and from radiating of signal from dielectric material. The given parameters are responsible for selecting the dielectric constant material:

- relative dielectric constant ϵ

- Substrate height h

- Loss tangent, tan δ

Hence, in order to account for radiation and a loss mechanism, one must introduce a radiation resistance Rr and a loss resistance Rl. A lossy cavity would now represent an antenna and the loss is taken into account by the effective loss tangent δeff which is given as:

$$\delta\text{eff} = \tan \delta + \frac{\Delta}{h} + \frac{\text{Pr}}{\omega \text{rWr}}$$

The given equation describes the total effective loss tangent for the microstrip patch antenna.

3. **CALCULATING PARAMETERS:**

The transmission line model described earlier will be used to design the antenna. The following equations are used to calculate the required dimensions for S-band.

1 Calculation of the Width (*W*):
The width of the fractal patch antenna is given as:

$$w = \frac{c}{2f \cdot \sqrt{\left(\frac{\mathcal{E}r + 1}{2}\right)}}$$

Where,

$c = 3 \ x \ 10^8 m/s$

$$W = \frac{c}{f_r} \sqrt{\frac{2}{\epsilon + 1}}$$

f_r = operational frequency

ϵ = permittivity constant of a material

2 Calculation of the **Bandwidth (Bw):**

Bandwidth is a measure of frequency range and is typically measured in hertz. For an antenna that has a frequency range, the band width is usually expressed in ratio of the upper frequency to the lower frequency where they coincide with the -10 dB return loss value. The formula for calculating bandwidth is given by:

$$\%Bw = \frac{fh - fl}{\sqrt{fhfl}} x^{100\%}$$

3 Computation of effective dielectric constant (ϵ_{eff}):

Effective dielectric constant the value of effective dielectric constant is given lower than permittivity of the substrate. However also more in the air. So, it's defined as-

$$\epsilon_{eff} = \frac{\epsilon + 1}{2} + \frac{\epsilon - 1}{2} [1 + 12\frac{h}{w}]^{-1/2}$$

Where,

h is height.

w is width of substrate material.

4 Calculation of the length (L):

The length is:

$$L = \frac{c}{2f_e \sqrt{\mathcal{E}r}}$$

For narrow band proved to be an important factor as it determines resonant frequency. The value of length is given by-

$$l_{eff} = \frac{c}{2f_r} \frac{1}{\sqrt{\epsilon_{eff}}} - 2dL$$

Here dL is the length extension and its value can be determined by using equation-

$$dL= 0.412h\frac{(\varepsilon_{eff} + 0.3)\,(\frac{w}{h} + 0.264)}{(\varepsilon_{eff} - 0.258)\,(\frac{w}{h} + 0.8)}$$

5: Feeding technique is used: The Coaxial feed or probe feed is a very common technique used for feeding Microstrip patch antennas. The inner conductor of the coaxial connector extends through the dielectric and is soldered to the radiating patch, while the outer conductor is connected to the ground plane. An idealization that simplifies the computation is to replace the electric current by a uniform line current ribbon. To determine the probe impedance for a microstrip antenna, the canonical problem of a parallel plate waveguide fed by a coaxial line has been analyzed using the integral formulation. The main advantage of this type of feeding scheme is that the feed can be placed at any desired location inside the patch in order to match with its input impedance. This feed method is easy to fabricate and has low spurious radiation.

However, its major drawback is that it provides narrow bandwidth and is difficult to model since a hole has to be drilled in the substrate and the connector protrudes outside the ground plane, thus not making it completely planar for thick substrates And its location There are four techniques are used microstrip line feed, coaxial feed, proximity coupled feed and aperture coupled feed. The most common technique is coaxial feed. In this the inner layer is extend from side of dielectric and is soldered to the patch, whereas outer one is linked to ground plane. The core benefit of using coaxial feed is feed can be positioned at any looked-for location to equivalent its input impedance. Thus, increasing return losses, bandwidth and performances. Using following equation one can calculate feed point-

Patch's width
$$A_f = \frac{w}{2}$$

Patch's length
$$B_f = B_o - dL$$

Here,

$$B_o = \frac{l}{\Pi} cos^{-1} \sqrt{\frac{50}{Y_o}}$$

$$\Rightarrow Y_o = \sqrt{50 * Y_{in}}$$

$$\Rightarrow Y_{in} = 90 * \frac{\varepsilon^2}{\varepsilon+1}\left(\frac{l}{w}\right)^2$$

4. PROPOSED GEOMETRY:

FR-4 glass epoxy is a popular and versatile high-pressure thermo set plastic laminate grade with good strength to weight ratios. With near zero water absorption, FR-4 is most commonly used as an electrical insulator possessing considerable mechanical strength. The antenna is designed a triangle shapes.

Fig 4(a) First iteration:

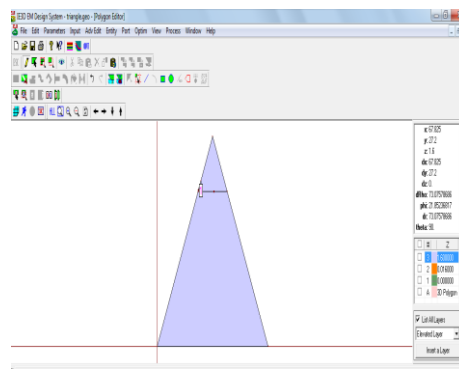First iteration is shown in fig. 4(a) in which shape is generated within the base shape.

Fig 4(a) Designed for geometry for zero iteration

Fig 4(b) Second iteration

Second iteration is shown in fig. 4(b) in which shape is generated within the base shape.
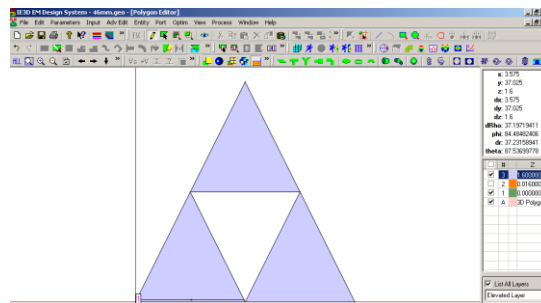
Fig 4(b) Designed Geometry for 1st iteration

Fig 4(c) Third iteration:

Third iteration is shown in fig. 4(c) in which shape is generated within the base shape.
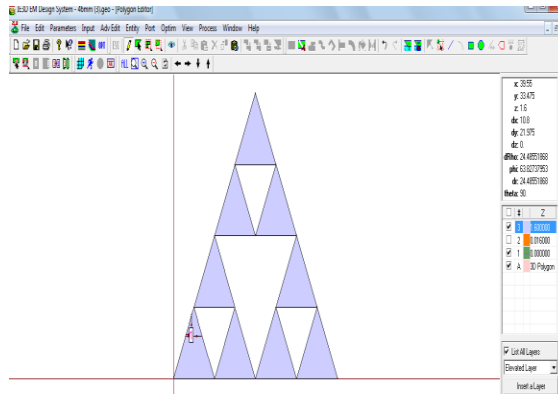
Fig 4(c) Designed Geometry for 2nd iteration

For designed VSWR, fractal shape antenna, Return loss, & Radiation pattern

5. RESULTS AND CONCLUSION:
The response of antenna is compared to others.
5.1 FR-4
This paper of antenna is used for FR-4 constant materials.The design and simulation is done using simulation software–IE3D-14.65. I have designed three antennas based on fractal, so called fractal antenna for S-band (2-4 GHz) , and I got the results for this band, which is used in short range communication. The antenna is designed on FR4 substrate with dielectric constant 4.4 and substrate height 1.6 mm.

5.1.1 Simulation results
In this MOM method is used for iteration of structure. Voltage source is 1 volt and frequency range is from 1GHz to 5 GHz. the return loss of the antenna. The radiation patterns are shown from figure.

Zero iteration Result:
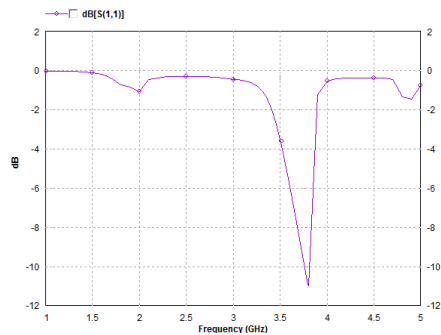
Fig 5(a) S parameter display for S (1, 1)

Fig.5 (a) shows the return loss of the antenna. Here it can be seen that it has resonant frequency at about 3.8 GHz with the return loss of about -11 dB. Bandwidth of the antenna as calculated is 2.15%.
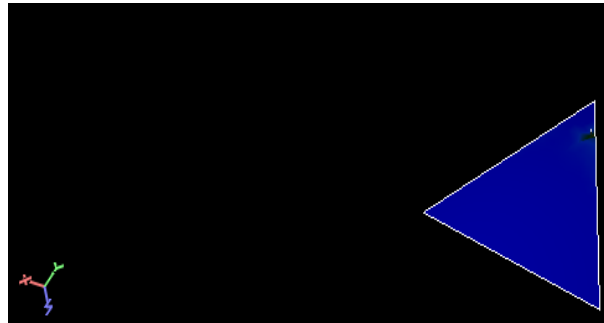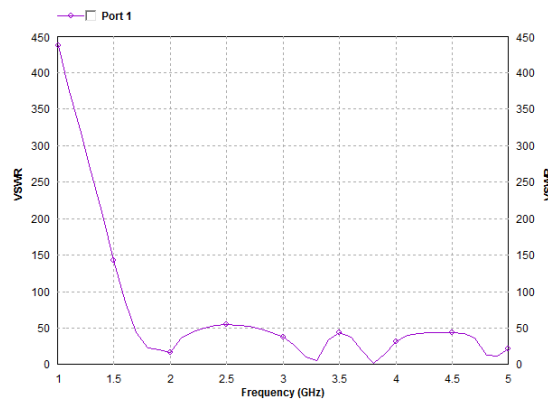

Fig 5(b) 3D Current Distribution
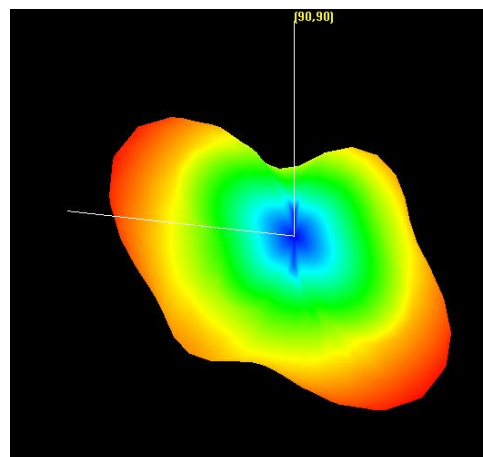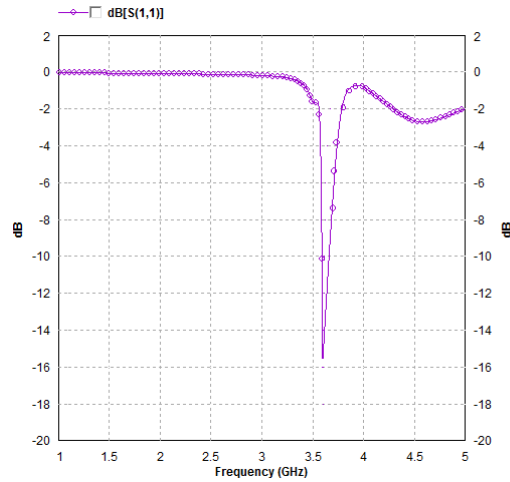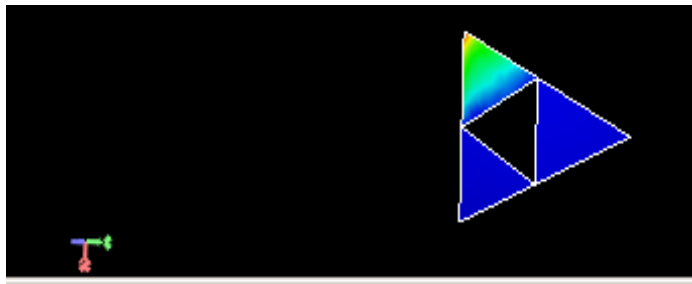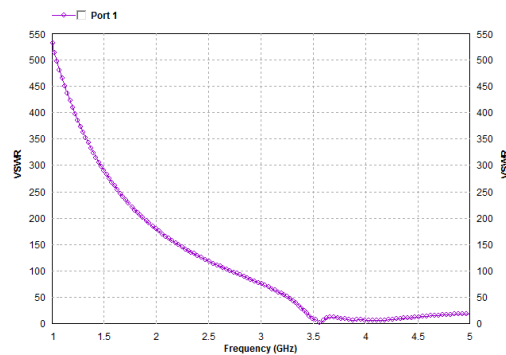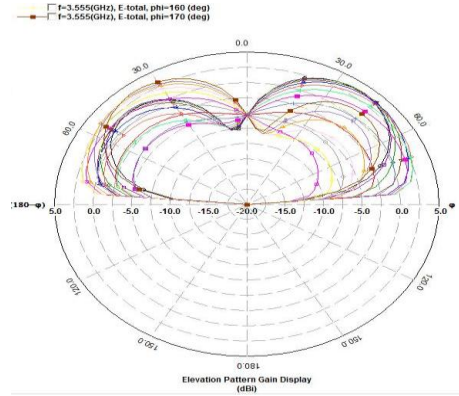

Fig 5(c) VSWR for Port 1

Fig 5(d) 3-D Pattern Display

(b) 1st **Iteration:**

Fig 5(e) S parameter display for S (1, 1)

Fig 5(e) shows the return loss of the antenna. Here it can be seen that it has resonant frequency at about 3.6 GHz with the return loss of about -15 dB. Bandwidth of the antenna as calculated is 1.65%.

Fig 5(f) 3-D Current Distribution

Fig 5 (g) VSWR for Ports 1
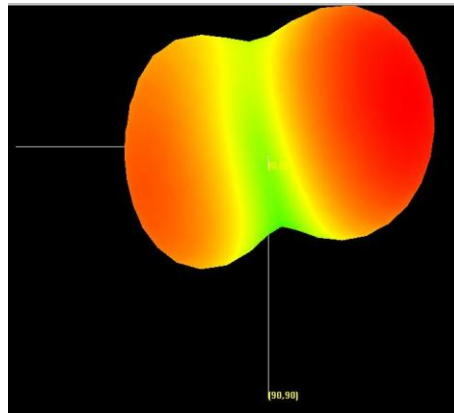
Fig 5(h) Elevation Pattern Display

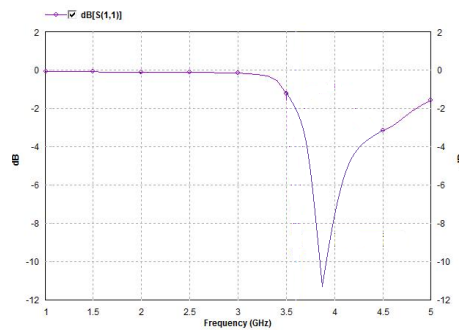**Fig5 (i) 3-D Pattern Display**

2ⁿᵈ Iteration

Fig5 (j) S parameter display for S (1, 1)

Fig. 5(j) shows the return loss of the antenna. Here it can be seen that it has resonant frequency at about 3.8 GHz with the return loss of about -11 dB. Bandwidth of the antenna as calculated is 3.4%.
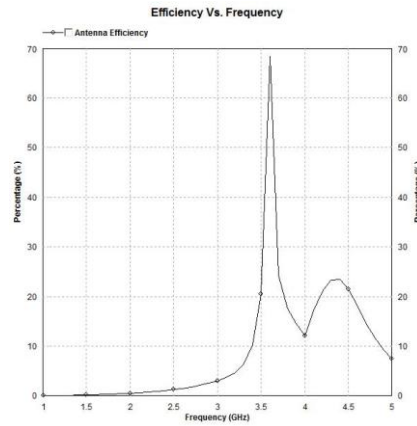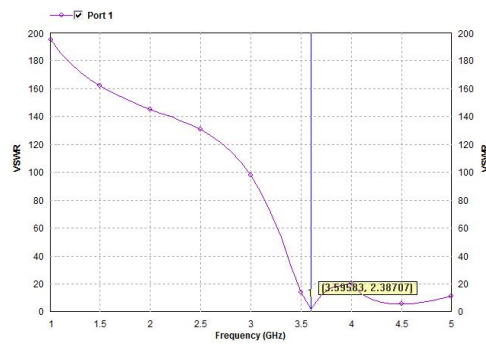

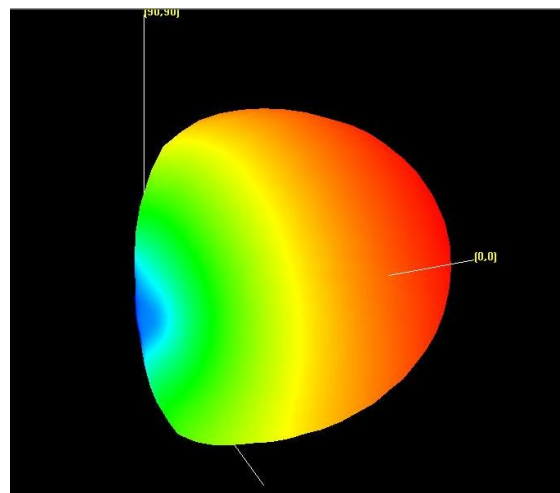**Fig 5(k) Antenna Efficiency Vs Frequency**

Fig 5 (l) VSWR for Ports 1

Fig5 (M) 3-D Pattern Display
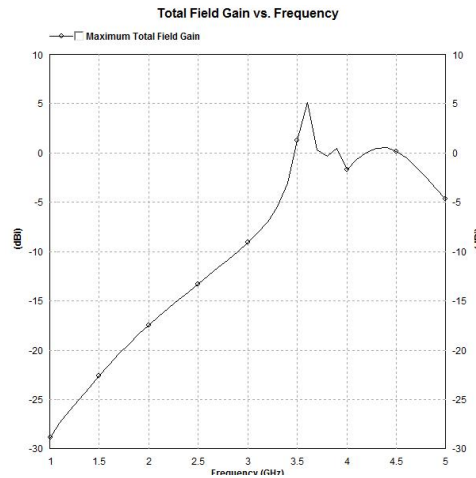
Fig 5(n) Total gain Vs Frequency

SUMMARIZING OF RESULTS

PARAMETER	Zero iteration	First iteration	Second iteration
Frequency	**3.8GHZ**	**3.6GHZ**	**3.8GHZ**
Bandwidth%	**2.15%**	**1.65%**	**3.4%**
Return loss	**-11dB**	**-15dB**	**-11dB**

CONCLUSION – Result indicates that the feed location has huge impact on the antenna parameters and by changing them they vary. The design of the planar fractal antenna for the S band has been presented. The work includes designing, simulating, fabricating, and measuring the return loss and radiation pattern of the proposed antenna has been done. The designing process is based on different designs that have been proposed in Published journals. The design and simulation is done using simulation software–IE3D-14.65. I have designed three antennas based on fractal, so called fractal antenna for S-band (2-4 GHz) , and I got the results for this band, which is used in short range communication.

The fractal concept can be applied to advance the small size antenna's bandwidth. Also, the projected configuration has small dimensions .It is concluded that it's an improved antenna for 1-5 GHz range.

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